"There will always be those who need to criticize," Goldin added, referring to the agency's recent problems with spacecraft sent to Mars. "If we set mediocre goals, we would have had results, and we wouldn't have had failure."

NASA's next Mars mission is scheduled for 2001. Weiler said that NASA will announce a decision about the 2003 missions at the end of this month, and that a long-term strategy for Mars exploration will be announced in the fall.

For further information, visit the Web site:http://www.msss.com/mars_images/moc/June2000/index.html. *(See also GRL column in this issue of Eos, page 303.)*

Randy Showstack, Staff Writer

FORUM

Mars: The Next Steps

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In 1993, the National Aeronautics and Space Administration (NASA) began the Mars Surveyor program to fly small, focused missions to Mars at every launch opportunity (2-year intervals) using the "faster, better, cheaper" approach championed by administrator Dan Goldin. NASA's plans are now under intense scrutiny because of the loss of all spacecraft arriving at Mars within the past six months. Panels commissioned to study the failures have released reports enumerating technical, managerial, and program problems and made recommendations to address these lapses. Recent events also provide an opportunity to reconsider the larger picture of Mars exploration: What are the program's goals within the context of both the scientific community and the society that supports it, and what is the best strategy to achieve those goals?

Interest in Mars has involved its potential for life since the 1698 publication of *Kosmotheros*, in which the Dutch astronomer Christian Huygens speculated about life on the other planets in the solar system. Martian plant life was still considered possible 266 years later until the first of several Mariner spacecraft reached Mars and revealed it to be a desolate, dry, and intensely cold world. The assessment of Mars as a habitable planet plummeted to a new low 12 years later when the Viking landers, sent to search for life, found not life but conditions at the surface that are lethal to all life as we know it. However, the Mariner and Viking spacecraft also discovered that Mars has an ancient and complex surface wrought by a long history of impacts, volcanism, wind, dust, ice, and, at least occasionally, the flow of liquid water. A new paradigm arose of a planet with a warmer, wetter, and active past, once similar to primitive Earth, but now the contrasting outcome of a divergent course of events. The search for life (as fossils or hardy forms surviving in subsurface refugia) would take place within a broader effort to understand the planet's dynamics and evolution, and the Mars Surveyor program was to be the first step in that effort.

The 1996 claim of fossil life in the Allan Hills meteorite, thought to come from Mars, generated tremendous excitement and controversy, and triggered consequential changes in the program. A 2005 mission was planned to return samples from the surface in hopes of finding life in them. This influenced preceding missions. The payload for the (now-canceled) 2001 lander was principally a rover that would serve in later missions as a vehicle to find and retrieve samples. Instruments on the 2001 orbiter were primarily justified in terms of sample return landing site selection. The effort required to develop a sample return vehicle demanded that other orbiter science be eliminated after the 2001 mission. Further, instruments on landers were either to address sample return-related issues, or to make measurements deemed essential for future human missions to Mars. The exploration program would thereafter consist only of sample return missions into the second decade of this century.

The question of life on Mars is a profound one, but a single-minded focus on a yes or no answer is an intellectually impoverishing reduction of a planet as rich in phenomena and history as Mars. Life must be studied as a planetary process, and its habitat—the planet—must be studied to provide both cause and context. Even if we do discover Mars to be lifeless, the next obvious question is why. Life or no life, the exploration of a new world with alien landscapes shaped by unknown forces during an undeciphered history is compelling to both scientists and non-scientists. The enormous interest in the pictures returned by Mars Pathfinder, revealing a landscape far more lifeless than any on Earth, is a case in point.

Exploration is also an iterative process of successive discoveries and new pursuits. In the era of faster, better, cheaper, this requires more flexibility in scope and design than the advanced planning typical of the great survey missions such as Viking, Voyager, and Cassini. Future missions must have the opportunity to benefit both from successes and new discoveries, as well as from past failures. In a manner of speaking, the best strategy of exploration is to have no strategy, but to be well prepared for the next step ahead. Louis Pasteur's "chance favors the prepared mind" could be adapted as "chance favors the prepared program of exploration." Rather than commit to particular missions within a specified time, a program of Mars exploration should develop broad themes to which the scientific and engineering communities could respond with mission proposals, as is done with the NASA Discovery program.

A long-term Discovery-like program with the pace and consistency of purpose of the original Mars Surveyor program would greatly further our understanding of Mars and its potential for life. Sample return is one of many means of exploring Mars that should openly compete with other options in terms of risk, cost, timeliness, and reward. It is not necessarily the unique key to solving the question of Martian life. The Allan Hills experience has taught us that we cannot predict how we will detect signs of life on Mars any more than we can predict if we will detect it.

Ultimately, NASA's most important Mars mission is nurturing and preserving the public interest, scientific expertise, and technology, which are all required for exploring the planet. As explorers, we seek not the prize of an Apollonian race, but the thrill from each new step, and each new vista that step reveals. Mars is not going away. As long as the human species endures, it will continue to beckon new generations of explorers.

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